BaBar Detector Performance

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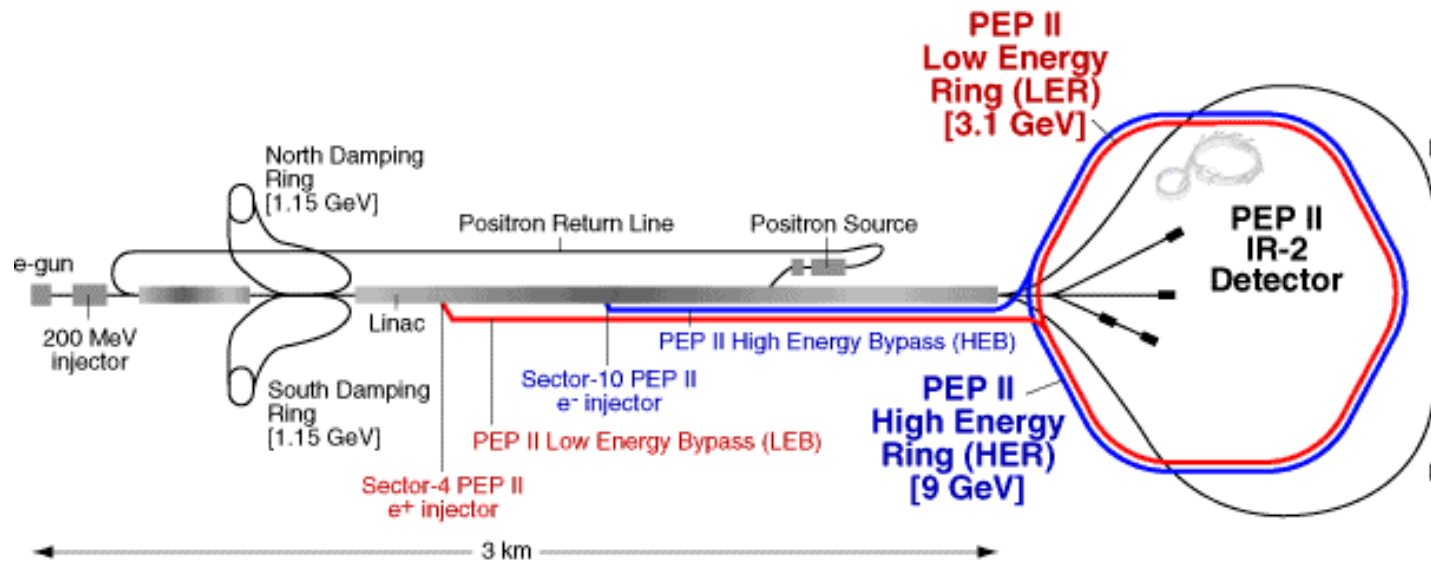
On behalf of the BaBar collaboration

3rd International Conference on $\mathcal{B}$ Physics and $\mathcal{CP}$ Violation

Taipei, December 3-7, 1999

Introduction (1)

- **The BaBar experiment is installed on the SLAC PEPII B-Factory**
  - **Asymmetric collider : e⁻ : 9 GeV - e⁺: 3.1 GeV ($\beta\gamma = 0.56$)**
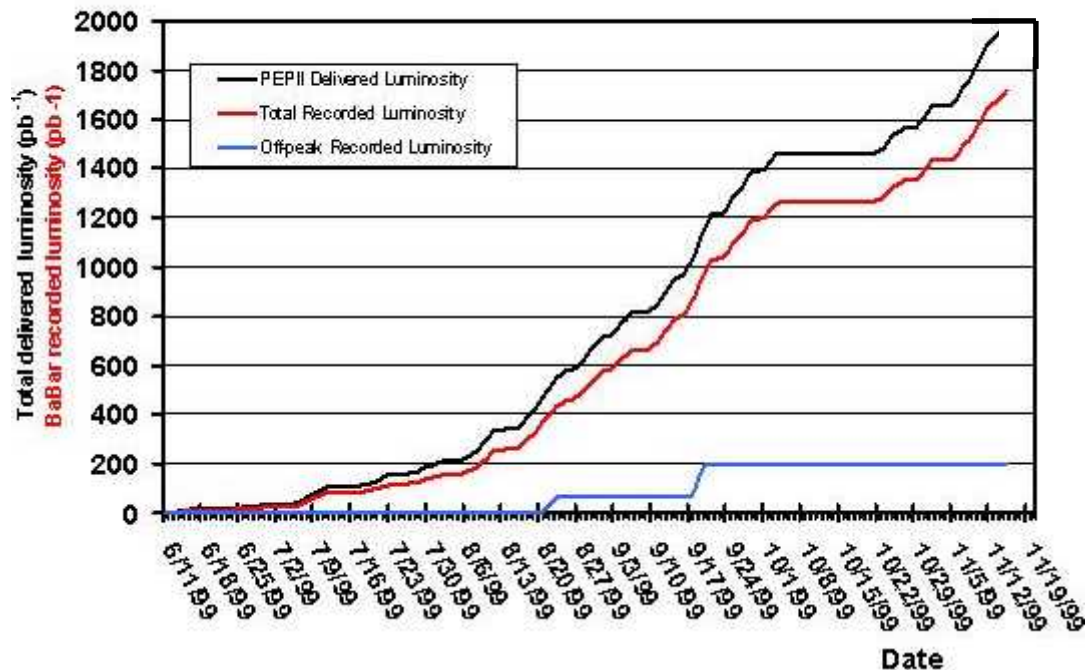

- **First hadronic event recorded May 26, 1999**

Introduction (2)

- **The main goal of the BaBar experiment is the measurement of the CP violation parameters**

- **It will also extensively study the B, charm, τ and 2-photon physics**
  - **First analysis plots will be shown by David Kirkby**

- **CP violation measurement as well as other B physics requires**
  - **Excellent tracking performance and vertex reconstruction**
  - **Ability to identify and measure γ and π^0**
  - **Excellent Particle Identification capability**
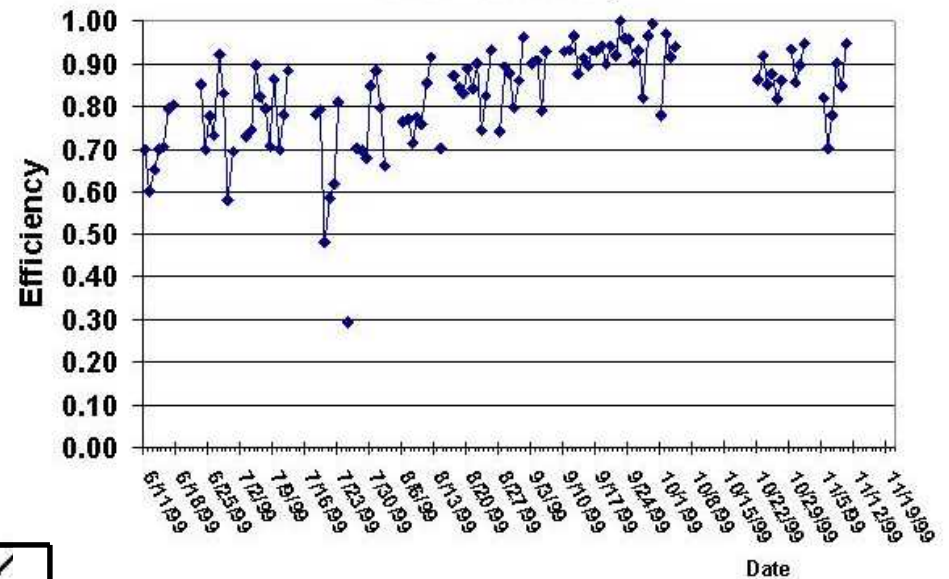 - **Muon and neutral hadron identification and measurement**

Integrated Luminosity

BaBar "efficiency"

November 19 : $\mathscr{L}$ **= 1.7 fb^{-1} on tape**

(2 fb^{-1} delivered)

BaBar Recorded Luminosity (BaBar L3)

BaBar Efficiency is now ~ 90 %

Beam Related Background

Silicon Vertex Tracker: Radiation Monitoring
using most sensitive PIN diodes near the IP

Dose Integral / kRad

- Dose Budget (1 kRad/day)
- HER-sensitive diode
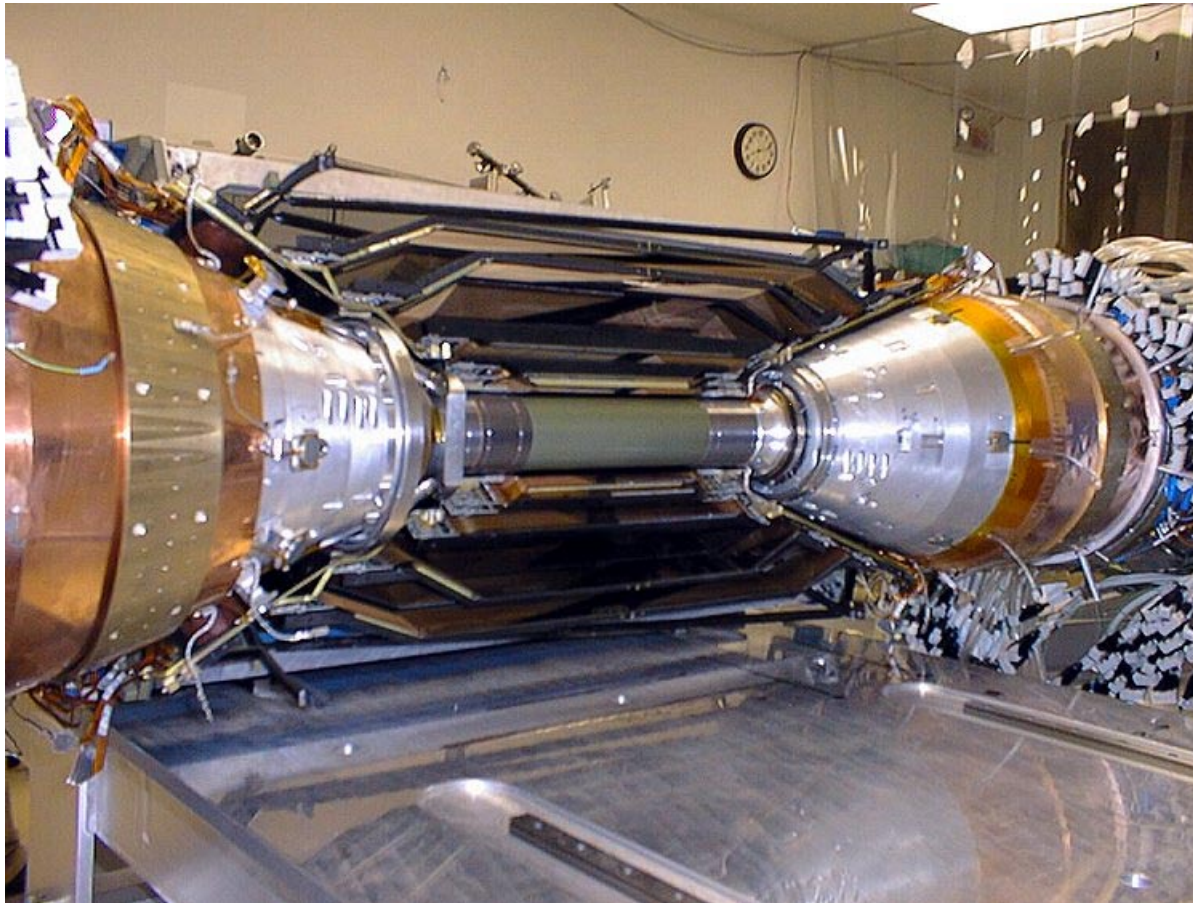- LER-sensitive diode

BABAR

Days of running
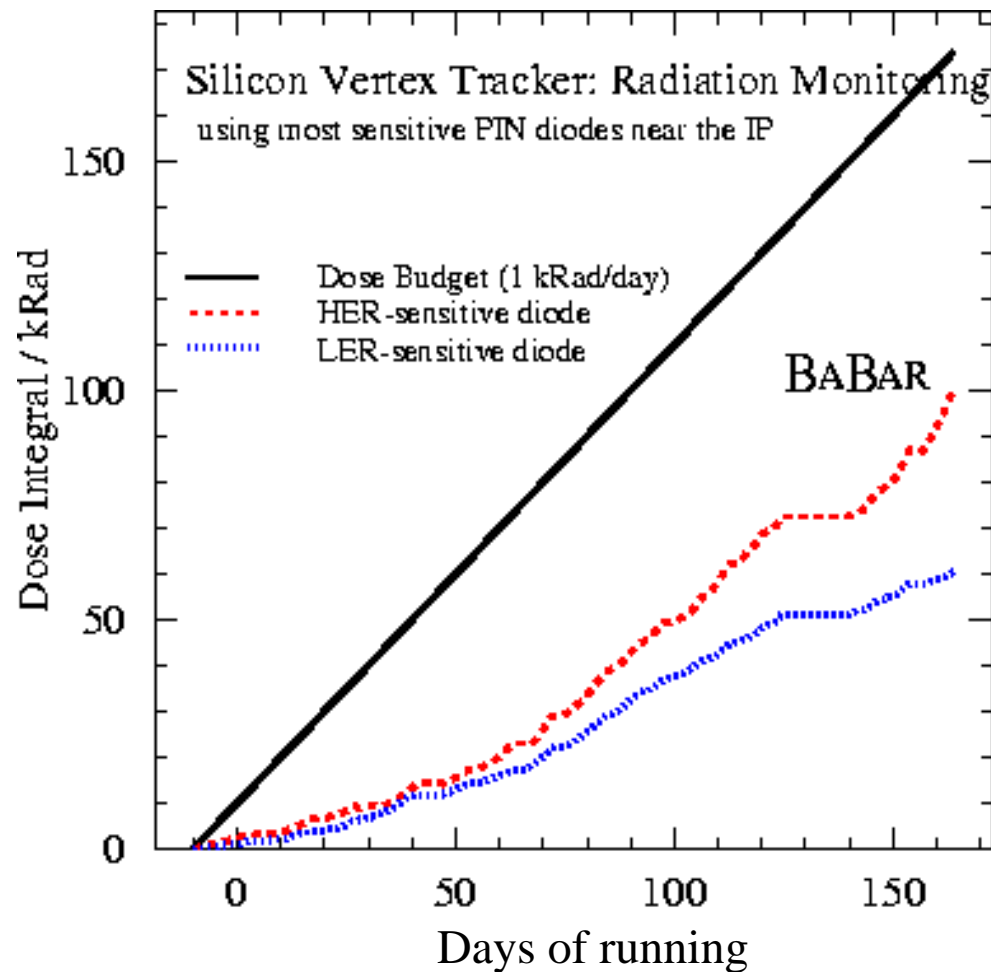
- **PEP II is providing clean beams**

- **The radiation dose received by the BaBar detector is well below the "budget" (240 kRad/year)**

The BaBar Detector

DIRC Pid

DIRC Stand-off Box

e^- (3.1 GeV)

Flux Return
RPC

CsI Calorimeter

Drift Chamber

e^+ (9 GeV)

Silicon Vertex
Tracker

Superconducting
Coil
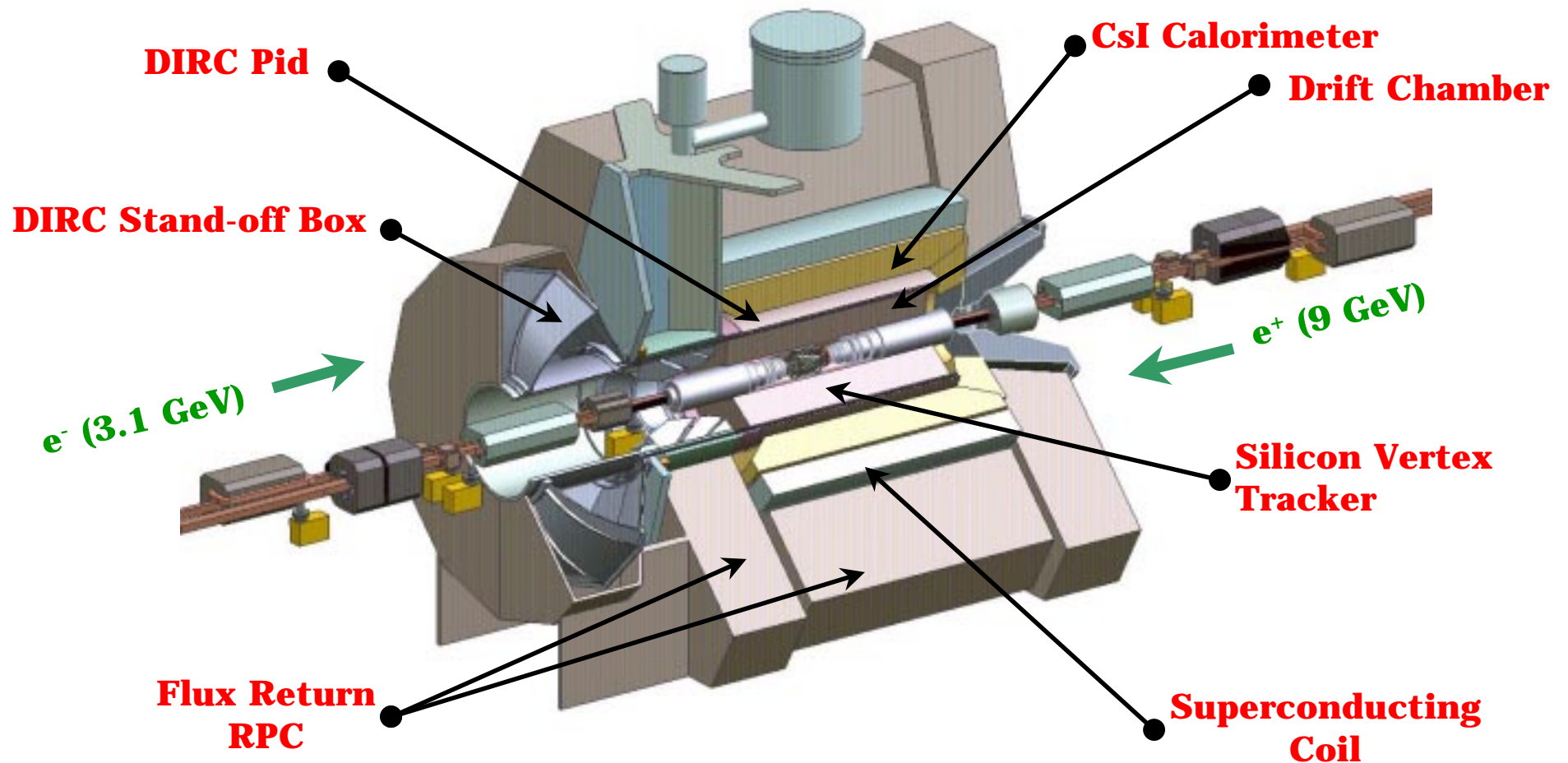
The Silicon Vertex Tracker

- **5 Double sided layers**

- **143K channels (0.94 m^2)**

- **Radiation Hard :**
  2 Mrad

- **Intended to provide excellent vertex resolution and tracking capability**

SVT Performance

SVT Hit Resolution vs. Incident Track Angle
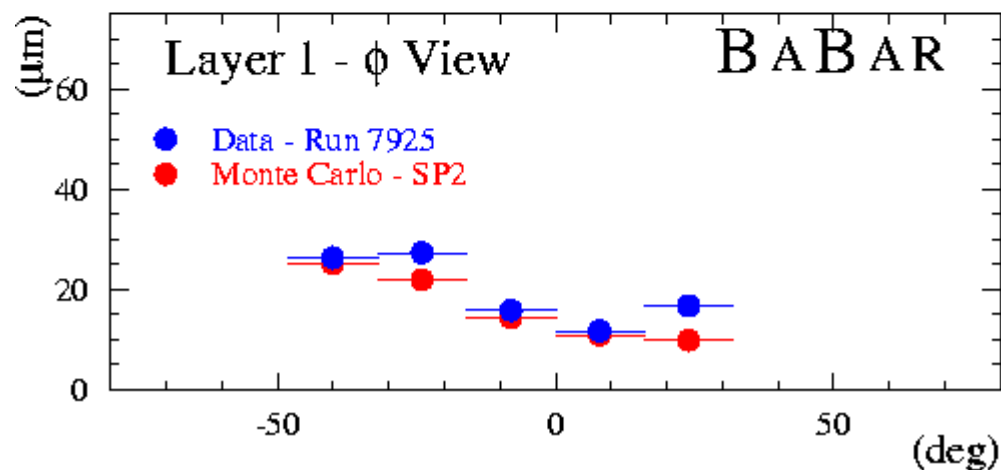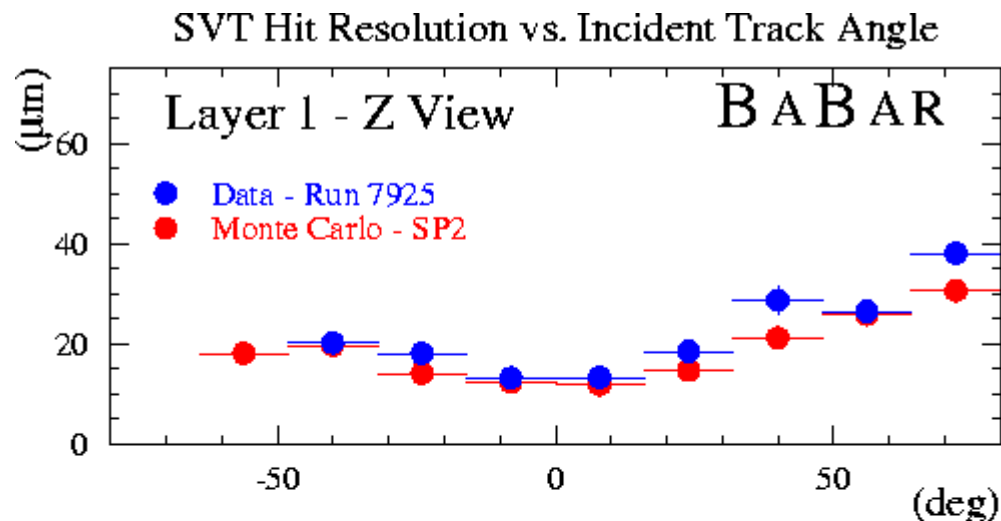
- **2 Track Bhabha events**

- **Plot shows the rms of the residuals of the hits associated to a track**

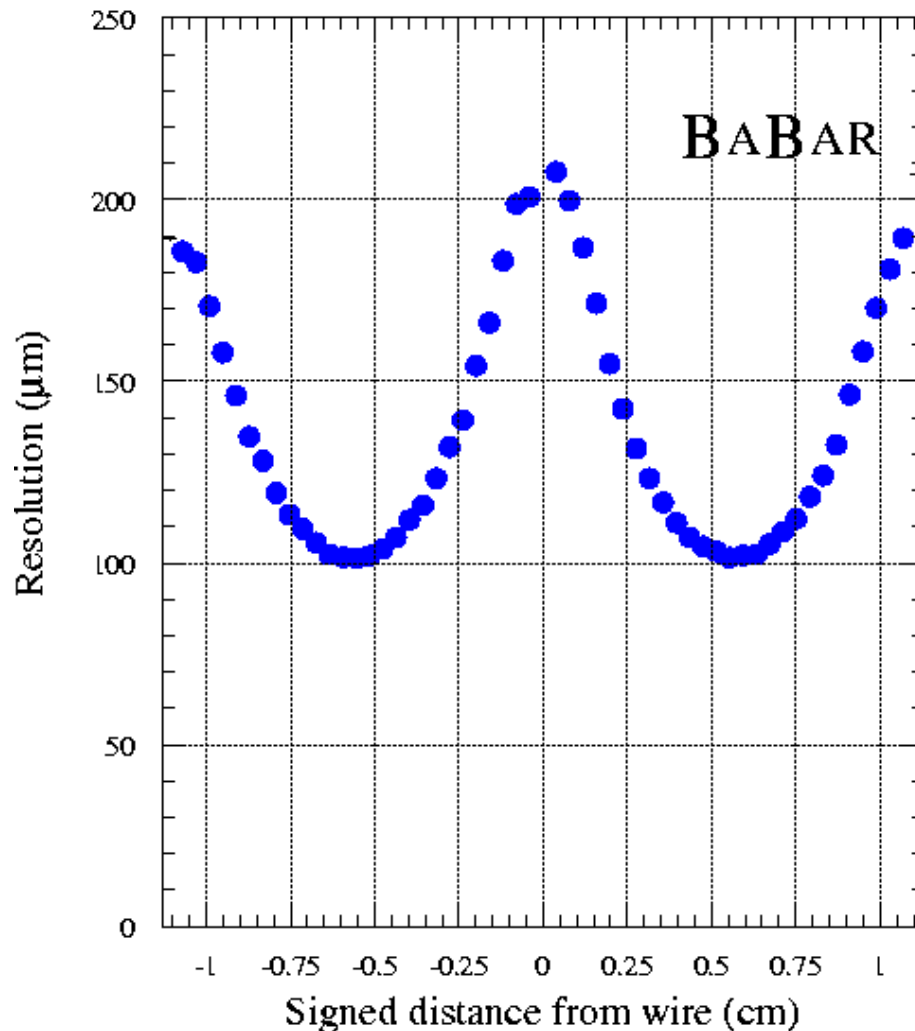- **Monte Carlo assumes perfect SVT alignment**

The Drift Chamber

Drift Chamber during installation in BaBar
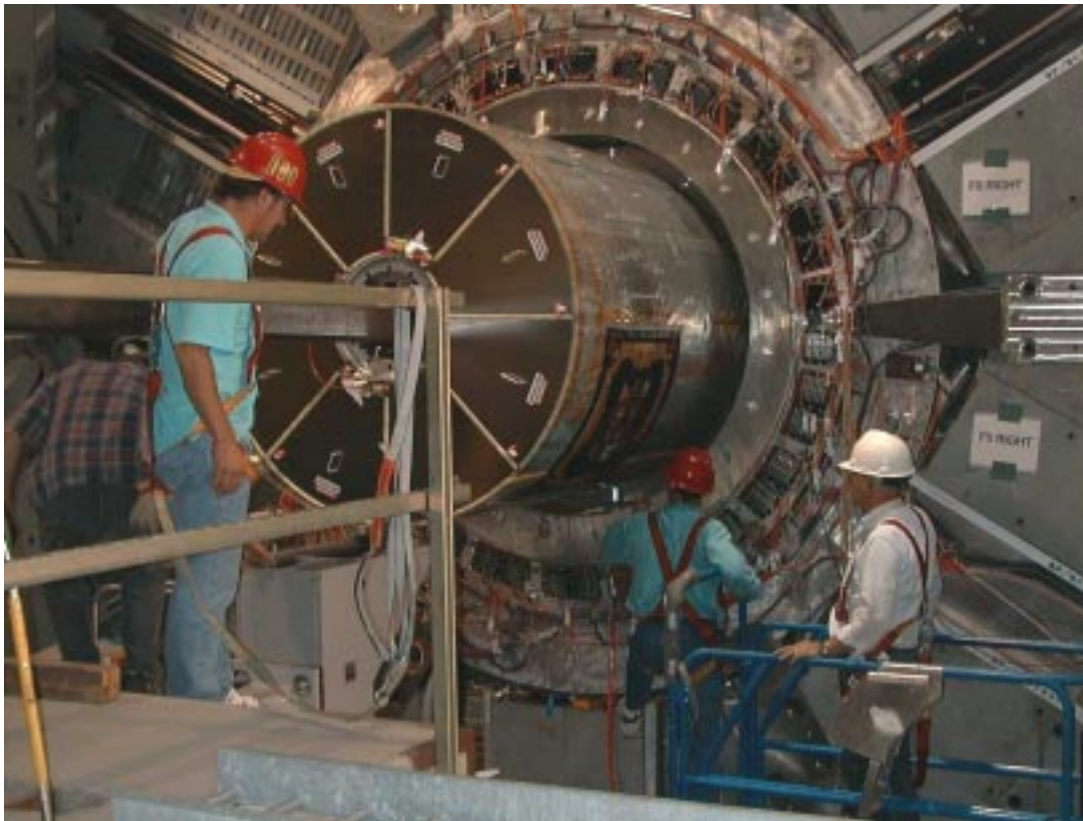
- **7100 hexagonal cells**
- **Organized in 10 axial and stereo Super Layers (40 layers)**

- **Maximum drift distance ~11 mm**

- **80%He-20%C_4H_{10} mixture**

- **Should provide good tracking capability and dE/dx Pid information**
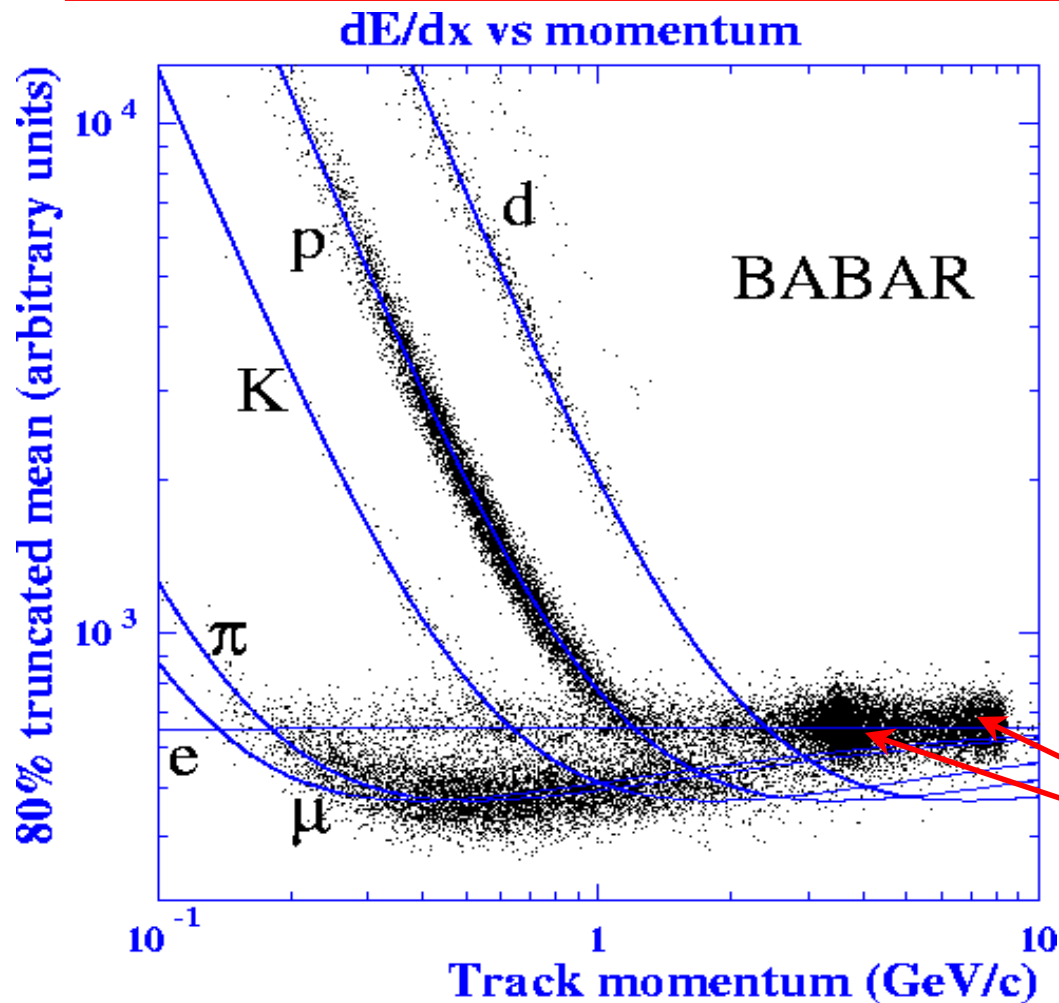
Dch Performance (1)

Drift Chamber Hit Resolution

BABAR

- **Single hit resolution as a function of the distance from wire**

- **Inclusive track selection - But dominated by Bhabha events**

- **(Weighted) Average resolution is <u>125 μm</u> to be compared to the <u>140 μm</u> of the design**
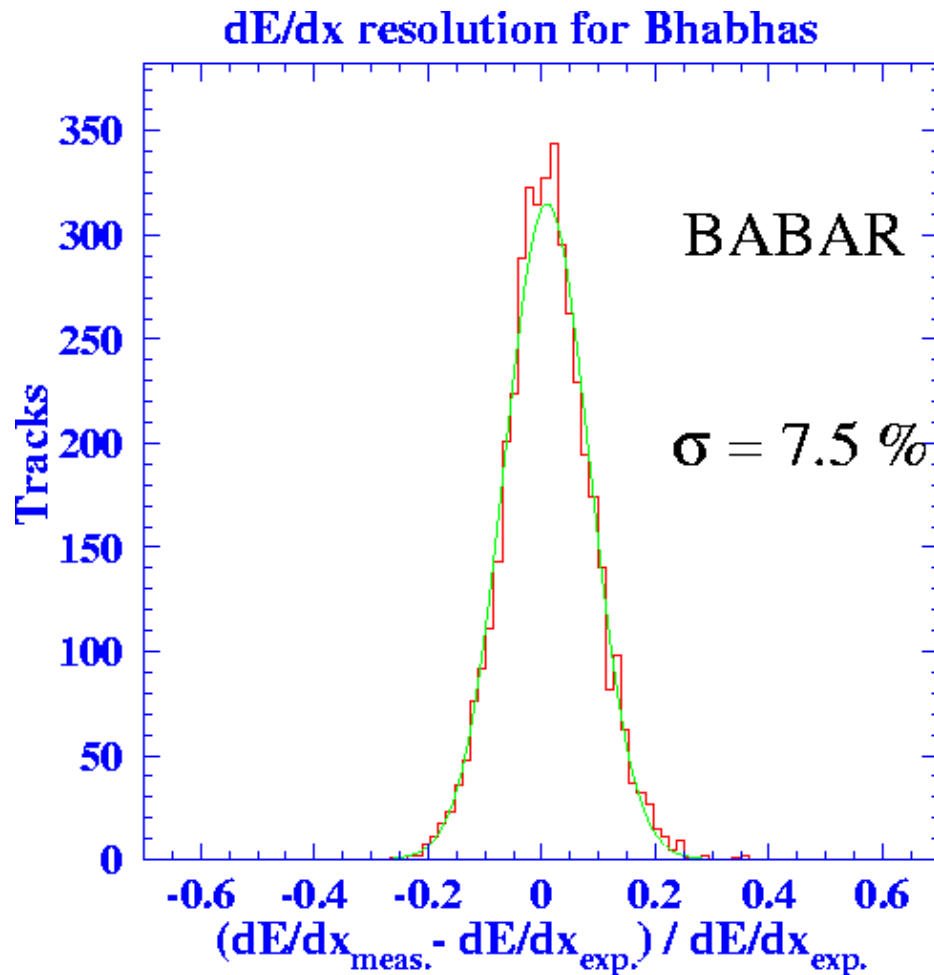
Dch Performance (2)

- dE/dx vs Momentum with Bethe-Bloch parametrization

- Most of the proton and deuteron are from Beam-Gas events

Dch will provide >3σ π/K separation up to ~700 MeV

Dch Performance (3)

dE/dx resolution for Bhabhas

BABAR

$\sigma = 7.5\ \%$

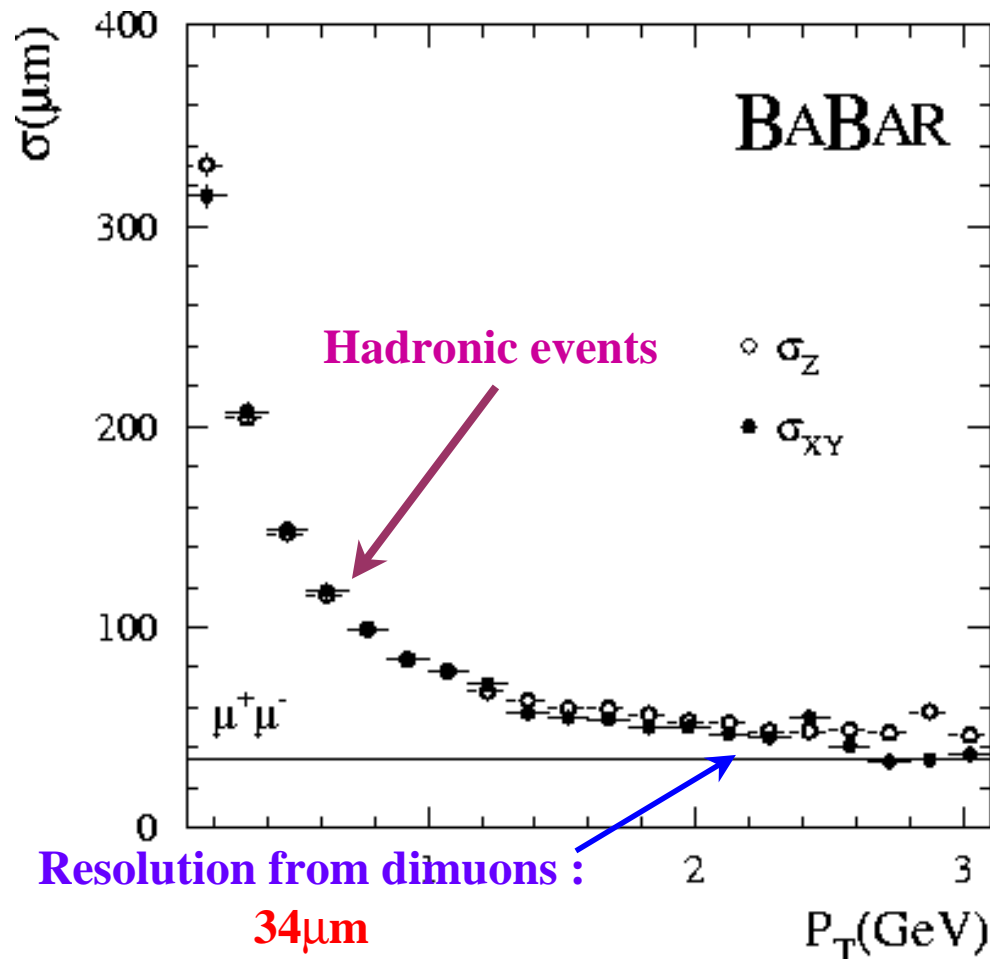(dE/dx$_{meas.}$ - dE/dx$_{exp.}$) / dE/dx$_{exp.}$

- **Loose cuts on track quality applied**

  7.5% resolution

- **BaBar should ultimately achieve 7% resolution when all the corrections will be applied**

Tracking Performance (Svt+Dch)

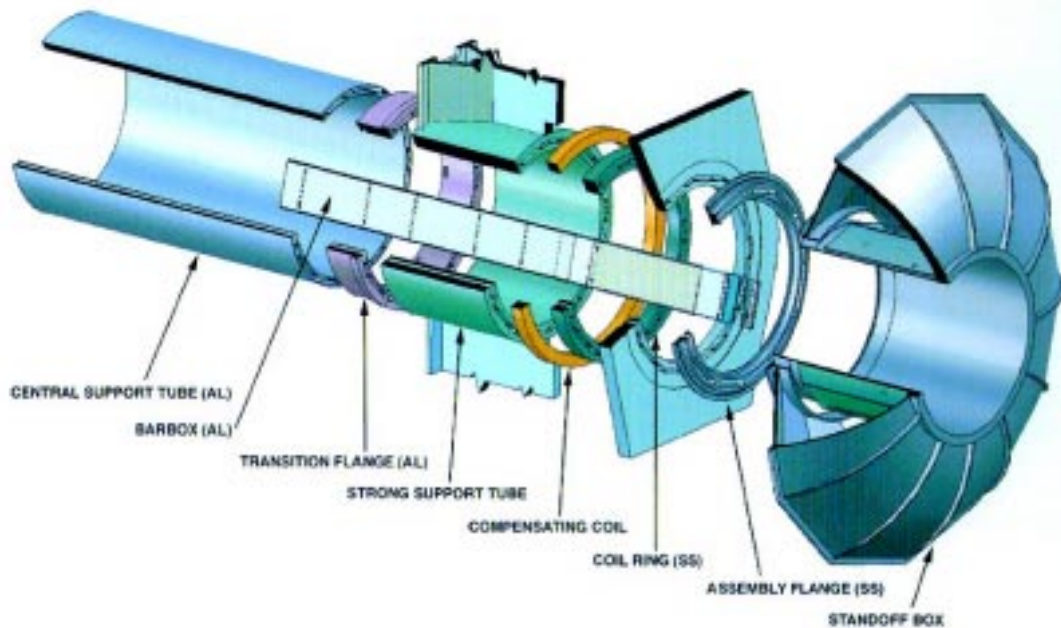**Resolution on distance of closest approach**

- **P_t resolution :**

    - **for $P_t > 3.5$ GeV/c**

    $$\frac{\sigma_{Pt}}{Pt} = 0.30\% Pt$$

    - **for Dch only**

    $$\frac{\sigma_{Pt}}{Pt} = 0.45\% Pt$$

The DIRC

CENTRAL SUPPORT TUBE (AL)
BARBOX (AL)
TRANSITION FLANGE (AL)
STRONG SUPPORT TUBE
COMPENSATING COIL
COIL RING (SS)
ASSEMBLY FLANGE (SS)
STANDOFF BOX

Detection of *Internally Reflected Cherenkov* light

- **144 Quartz bars**

- **5/12 of the quartz bars installed at BaBar Startup**

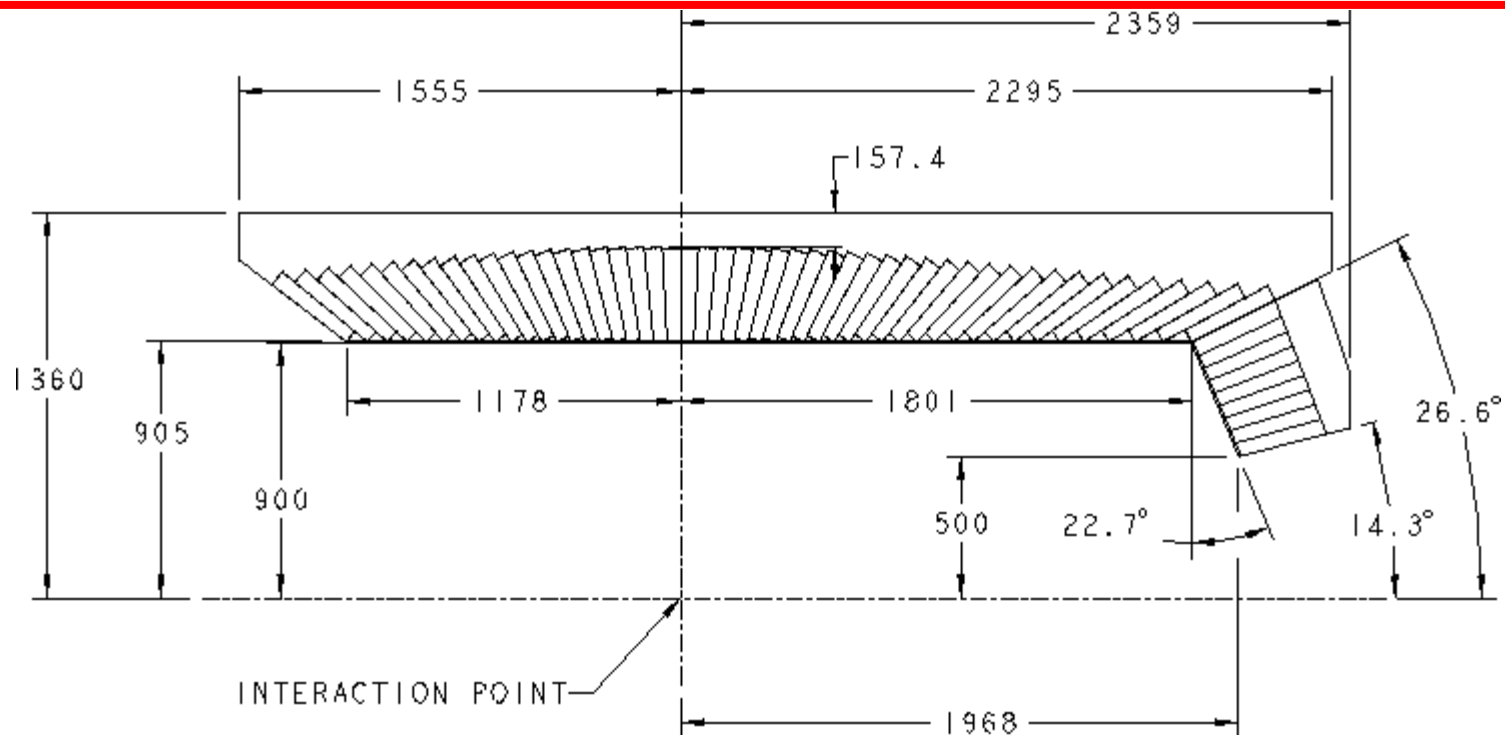**Complete since October**

- **See detailed talk from Marco Zito**

Illustration of DIRC performance
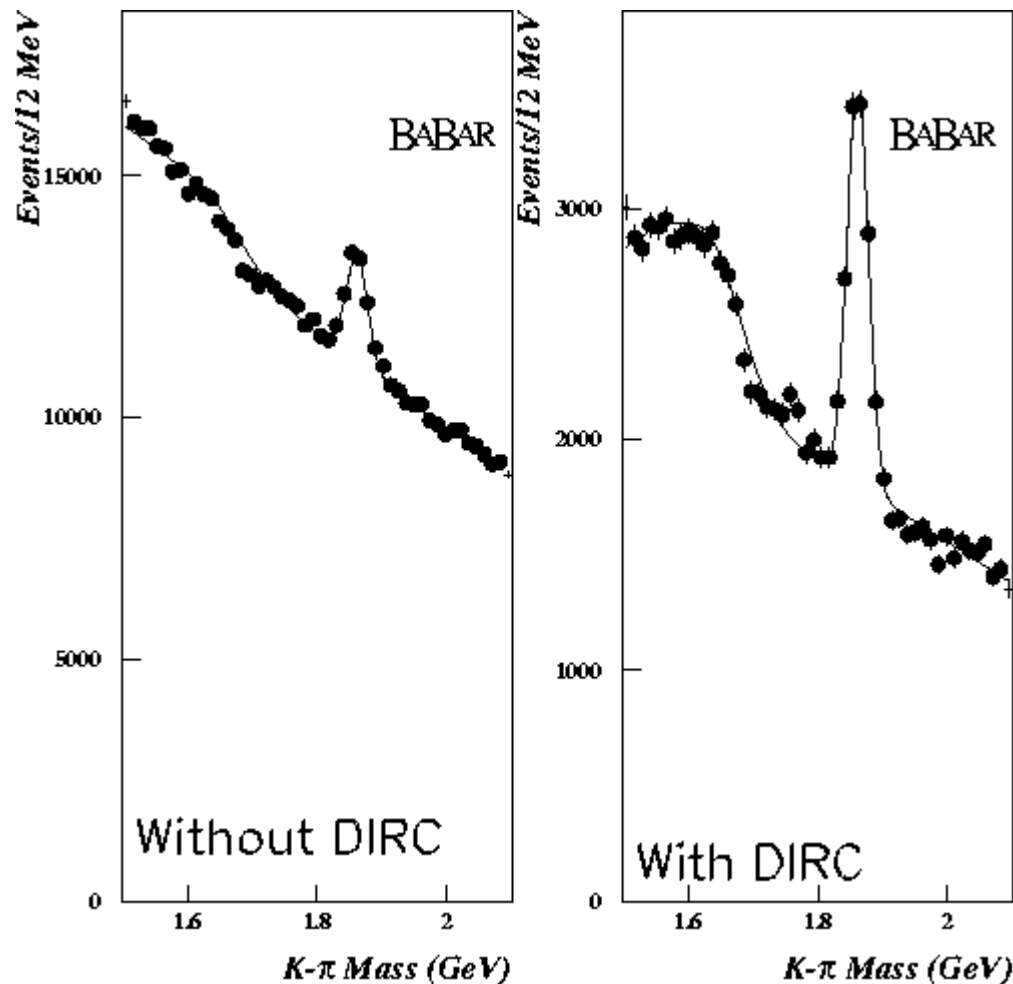
- $D^0 \rightarrow K\pi$ for $P^*_D > 1.5$ GeV/c

- $0.5 < P_K < 2.5$ GeV/c

- Kaons are selected in a 2σ region around the expected Cherenkov angle

- Kaon efficiency : ~80% for tracks pointing to the region covered by the quartz bars

- Background rejection factor under the D peak : 5
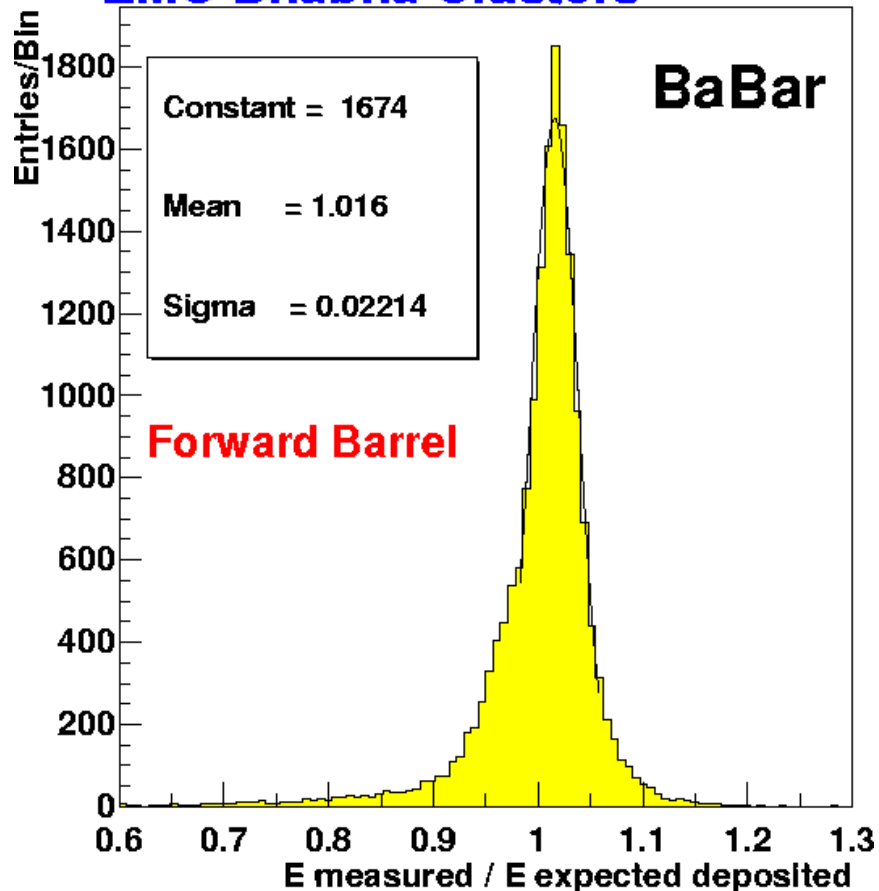
The CsI Electromagnetic Calorimeter

- **6580 CsI(Tl) crystal (5760+820)**
- **Material in front : 0.20-0.25 X_0**

- Readout by 2 large area photodiodes
- Liquid source for calibration in front of the crystals

Calorimeter Performance

**Ratio of measured to expected energy for bhabha events**

EMC Bhabha Clusters

Constant = 1674

Mean = 1.016

Sigma = 0.02214

Forward Barrel

BaBar

Entries/Bin

E measured / E expected deposited

- The expected $e^-(e^+)$ energy is computed from the track angle

- The low energy tail is due to Bremhsstrahlung

- Noise contributions :
  - Incoherent noise : 420 KeV
  - Coherent Noise : 380 KeV

  - Coherent noise can be reduced down to ~100 KeV

Calorimeter Performance

π^0 **Mass Peak**

π^0 Mass $E_{\gamma\gamma} > 500$ MeV

BaBar

π^0-mass = 134.2 MeV

π^0-width = 7.7 MeV
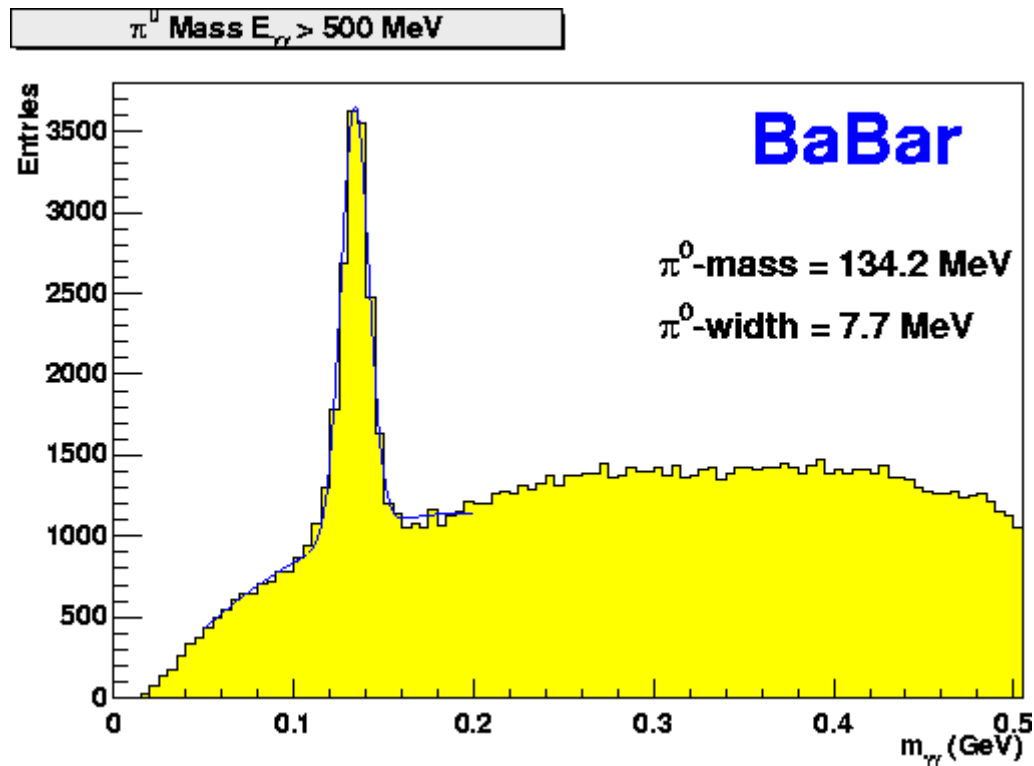
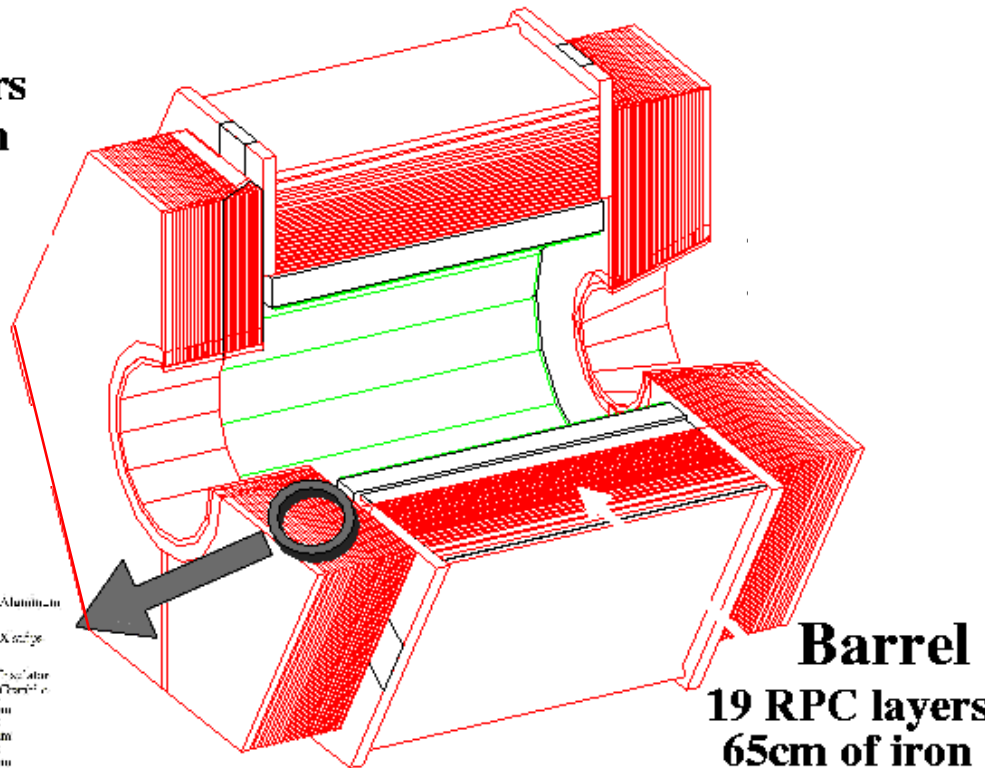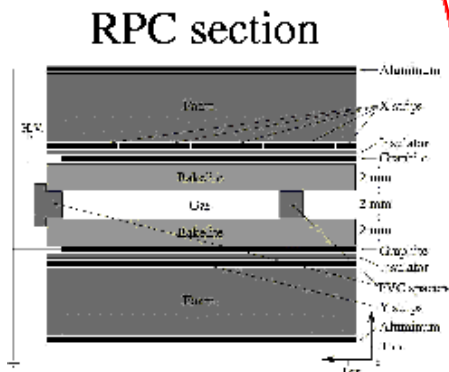- $E_\gamma > 100$ MeV
- $E_\pi > 500$ MeV

- **Improvements expected by reducing the coherent noise**

BaBar expects to achieve a resolution of 5.7%
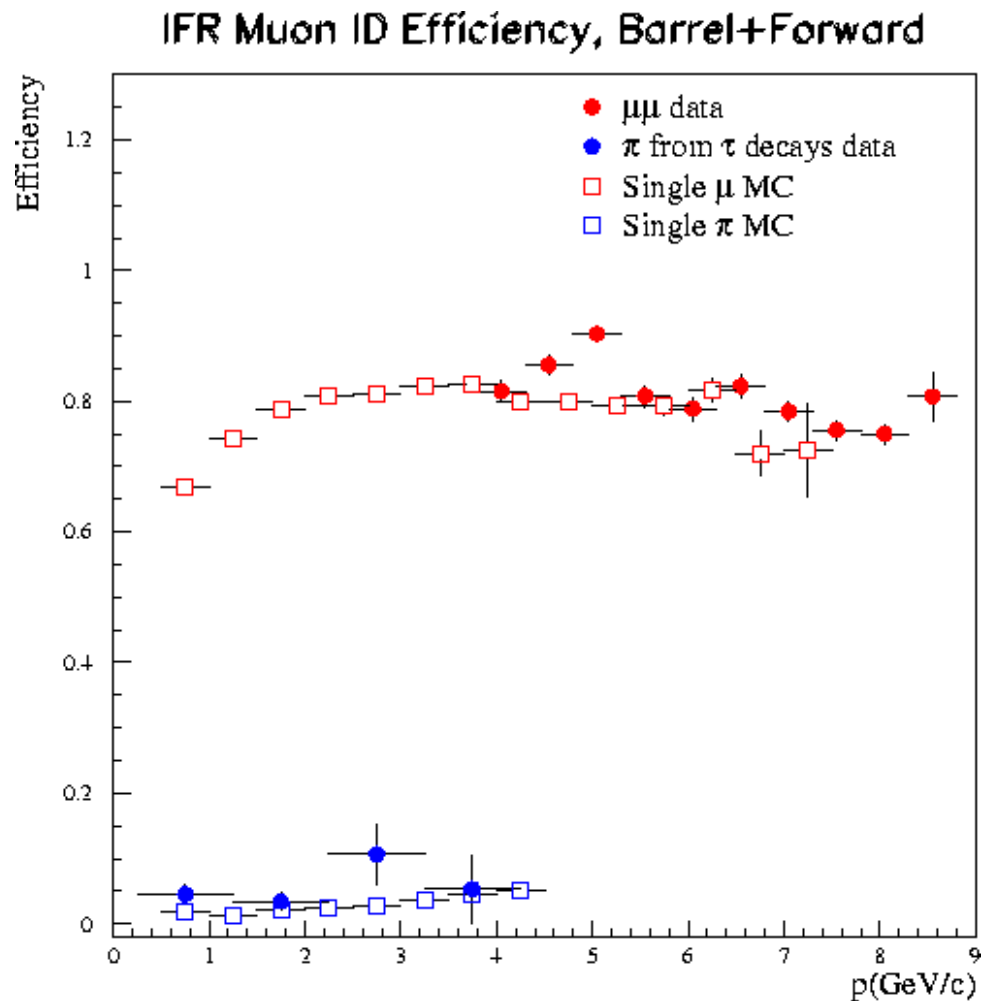
The Instrumented Flux Return (IFR)

Instrumented Flux Return


Endcap
18 RPC layers
60cm of iron

Barrel
19 RPC layers
65cm of iron

RPC section

- **Resistive Plate Chambers**

- **For Muon and Neutral Hadron detection (K^0_L)**

- **2 double-layer cylindrical RPC inside the coil**

IFR Performance

IFR Muon ID Efficiency, Barrel+Forward

- **Muon Id efficiency is computed from di-muon data (P > ~4 GeV/c).**

- **10% inefficiency due to detector geometry**

- **π contamination from pion decay in Dch or in the Emc (2.4/P(GeV) %)**

- **Punch-Through : 1.2%**

Data Processing Status

Event Production (Ev.diff.=4704646)
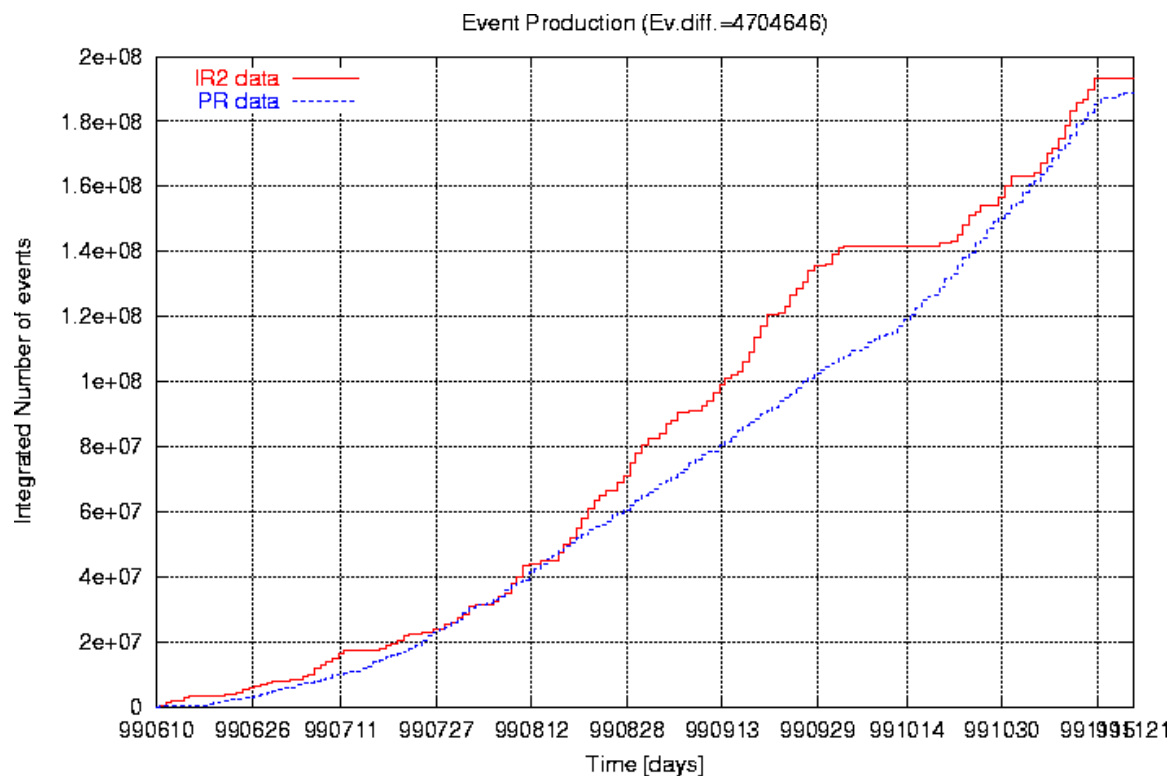
Sun Nov 21 01:28:23 1999

- **BaBar events are processed on a 100 computer-node farm**

  ➔ **prompt reconstruction**

- **~1.9 10[8] events have been processed so far**

Conclusions and Prospects

- **The PEPII collider is working very well and is routinely delivering luminosity in the 10^{33} cm^{-2}s^{-1} region**

- **The BaBar experiment has accumulated ~ 1.7 fb^{-1} since May**

The Detector is complete and is performing well

- **PEPII is now stopped to install permanent solutions to fix some leaks in the vacuum chamber**

- **PEPII/BaBar will restart January 3rd**

BaBar/PEPII goal is to accumulate 10 fb^{-1} by the time the run ends next summer